Space Weather Technical Forecast

Issued on Monday, 20 May 2024 at 01:17 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares throughout. Chance of G1-G2 (Minor/Moderate) Storm conditions day 1 and 2 (20 and 21 May).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at Moderate levels, with the largest flare a M2.5 event at 19/1756UTC from AR3685. There are currently nine sunspots on the visible disc. AR3685 is the largest sunspot region in the southeast, which comprises of a number of large and mature spots, with recent consolidation of some of the smaller spots. A small delta configuration is now apparent in one of the northern spots, giving it a Beta-Delta configuration. AR3679 in the southwest is the next largest region, although the main leader and trailer spots are well-separated with a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 in the southwest indicates modest magnetic complexity with numerous small trailing spots and some consolidation. The other sunspot regions are generally smaller, simpler and generally stable.

A large filament lift-off from the southern hemisphere that began around 18/2200UTC has been modelled as missing below Earth orbit. Another large filament eruption observed in the northwest is yet to be analysed for any potential Earth-directed component, but given its location, this is probably unlikely. Otherwise, no Earth-directed CMEs were observed in the past 24 hours in coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were indicative of a near background regime, though perhaps with minor positive coronal hole influence. Solar wind speeds have ranged between 360-440km/s. Density of the solar wind was predominantly below average, though briefly reached above average levels of 11ppcc at 19/0929 UTC. The Interplanetary Magnetic Field (IMF), Bt, started the period at weak levels, but increased to moderate levels between 19/1000-1800 UTC, peaking at 10nT, before declining back to weak levels. The north-south component Bz was predominantly weakly negative, but briefly reached moderately negative values between 19/1100-1300 UTC. Bz varied between +5/-9nT. Phi angle was predominately positive (away from the Sun) throughout the period. Geomagnetic activity was at Quiet to Unsettled levels (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels, but above normal background levels, on a slow decline. High energy electron flux (greater than 2MeV) observed by GOES-16 was at background to moderate levels, with a peak of 407 pfu at 19/1800UTC. The associated 24-hour fluence has remained below the Active threshold. Observed fluence at 20/0000 UTC of 9.78e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of

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significant flare activity.

Solar Wind / Geomagnetic Activity: There is the chance of a glancing blow from a CME at Earth late day 1 (20 May) or perhaps early day 2 (21 May), resulting from the M7.2 flare of AR3685 that occurred late on 17 May. In the absence of any CME arrivals, solar winds are forecast to remain at or near background speeds throughout the period with no significant coronal hole enhancements expected.

Quiet to Unsettled conditions initially, before a possible glancing blow from a CME (which left the Sun on 17 May) arrives at Earth late day 1 (20 May) or early day 2 (21 May) with a chance of Active to G1-G2/Minor-Moderate (Kp5-6) intervals and a slight chance of G3/Strong (Kp7) interval should we see a more significant impact. Activity should then subside towards Quiet to Unsettled levels by days 3 and 4 (22-23 May).

Energetic Particles / Solar Radiation: Proton flux is below the S1/Minor Storm threshold, on a slightly declining trend, but remains just above normal background levels following flare activity from the past week. There is a persistent slight chance of further enhancements should any large flares occur.

High energy electron flux is at background to moderate levels. However there is the potential for electron flux to rise and potentially reach high levels later in the period. Any rise in electron flux is expected to be curtailed by further CME influence, most likely occurring late day 1 (20 May) or early day 2 (21 May). The associated 24 hour fluence is expected to follow a generally rising trend through the period with a slight chance to reach the Active threshold by days 3 and 4 (22-23 May), though dependent on the extent of any CME enhancement.

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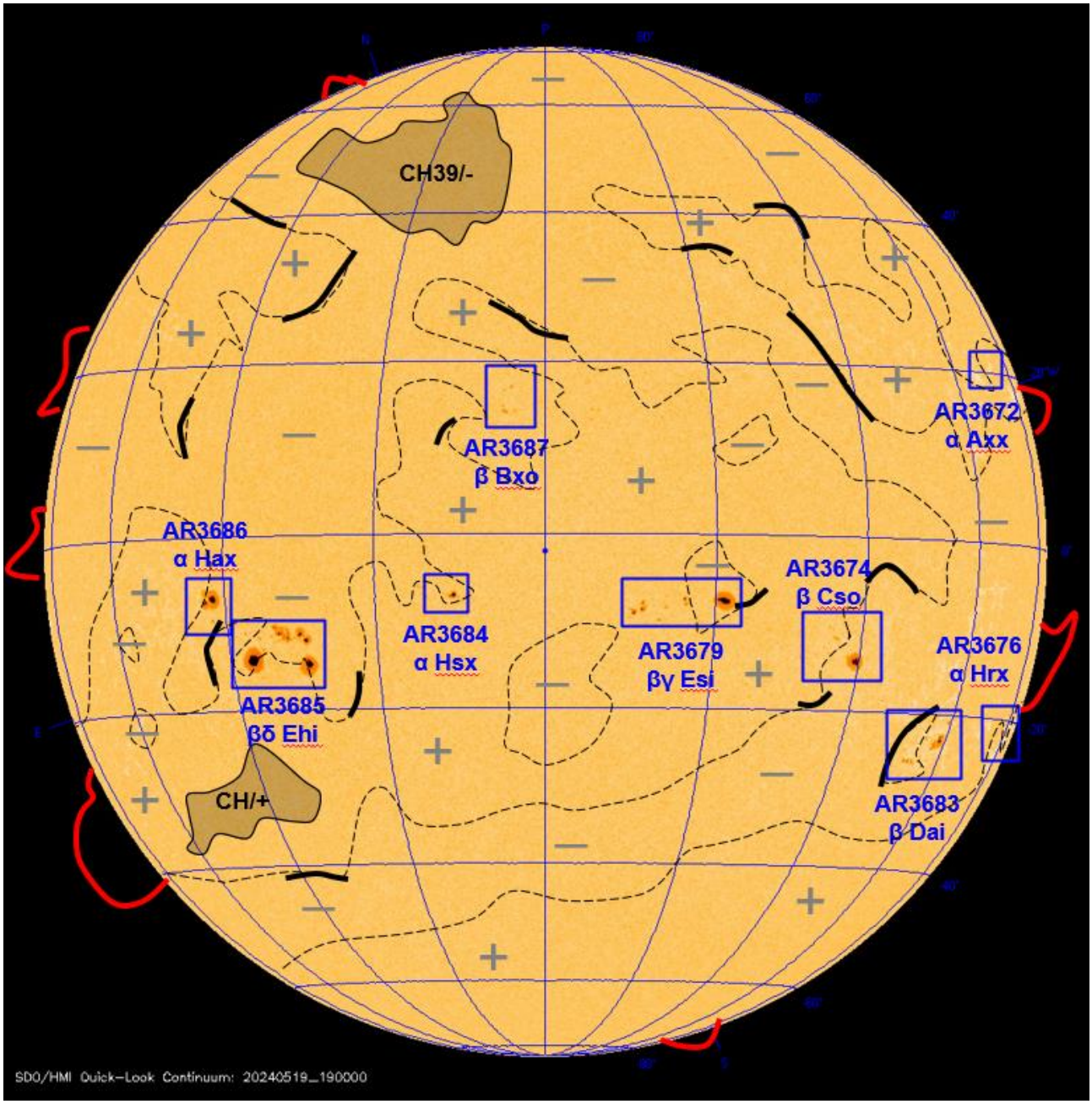
Figure 1. Solar Analysis Valid 19/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

One potentially Earth-directed CMEs currently features in the forecast period. Late on 17 May a complex 'double-structured' moderately-fast CME was seen in coronagraph imagery associated with the M7.2 flare of AR3685 in the southeast disc. Type II and IV Radio Emissions as well as a distinct EUV wave signature were observed. Modelling of this feature suggests the potential for a glancing impact late day 1 (20 May) or perhaps early day 2 (21 May).

In the absence of any CME arrivals, solar winds are forecast to remain at or close to background speeds, with no significant coronal hole enhancements expected.

Quiet to Unsettled conditions initially, before a possible glancing blow from a CME (which left the Sun on 17 May) arrives at Earth late day 1 (20 May) or early day 2 (21 May) with a chance of Active to G1-G2/Minor-Moderate (Kp5-6) intervals and a slight chance of G3/Strong (Kp7) interval should we see a more significant impact. Activity should then subside towards Quiet to Unsettled levels by days 3 and 4 (22-23 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	50	5	1
Strong	G3	No	10	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
18/0039	Partial	AR3635	SE	950km/s	20/2000 UTC	Chance of glancing impacts

Figure 2: MOSWOC Enlil and Ensemble, which shows the M7.2 flare CME passing mostly behind and below Earth' orbit late on 20 May or early 21 May, with a possible glancing blow.

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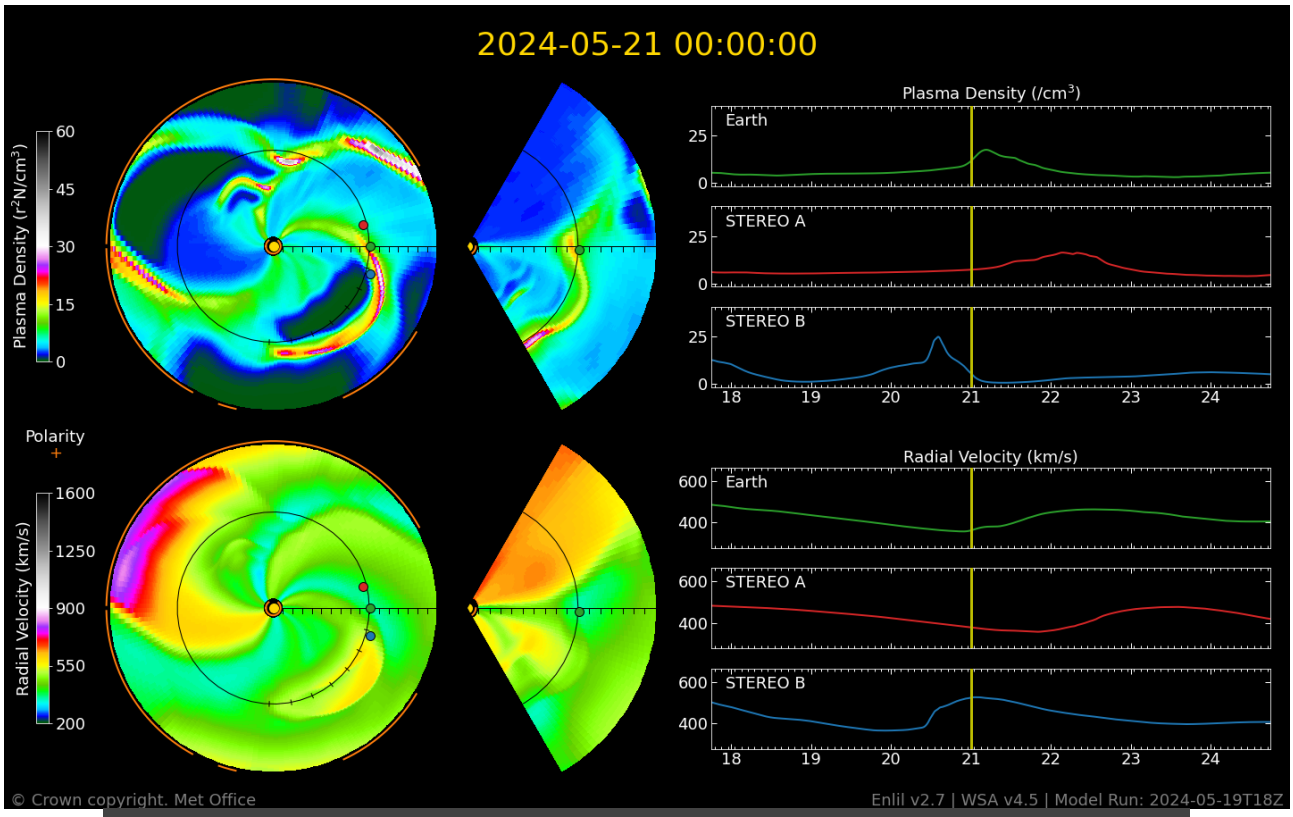

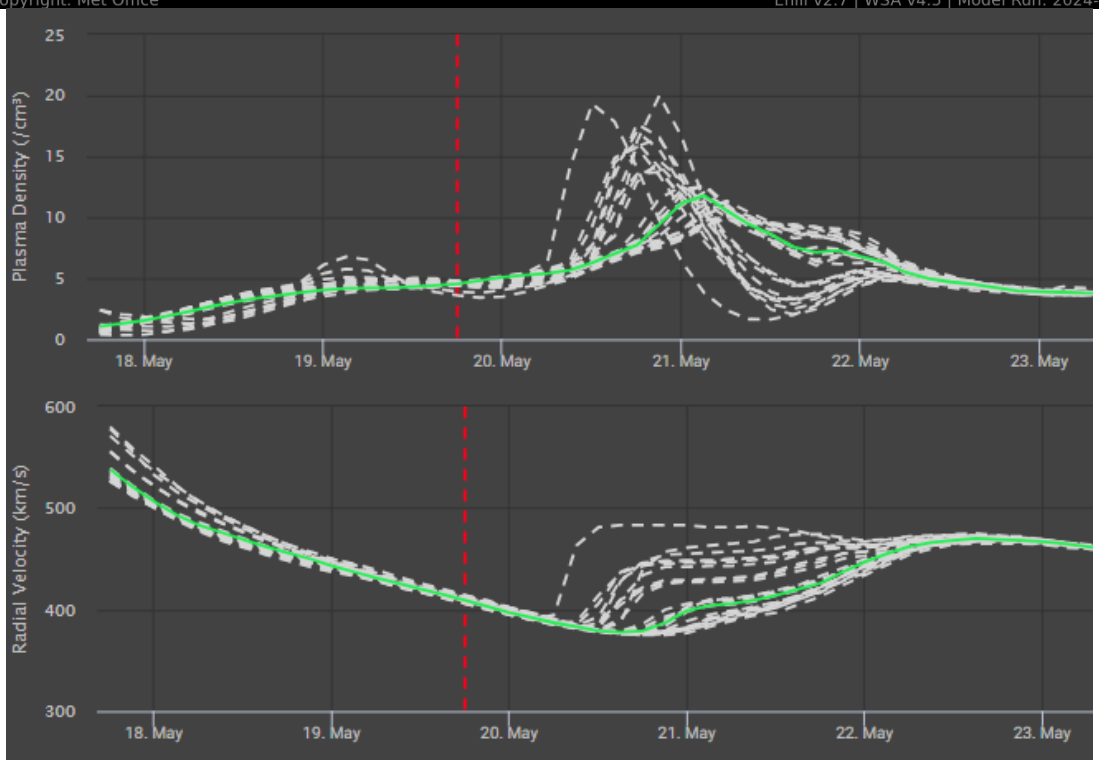

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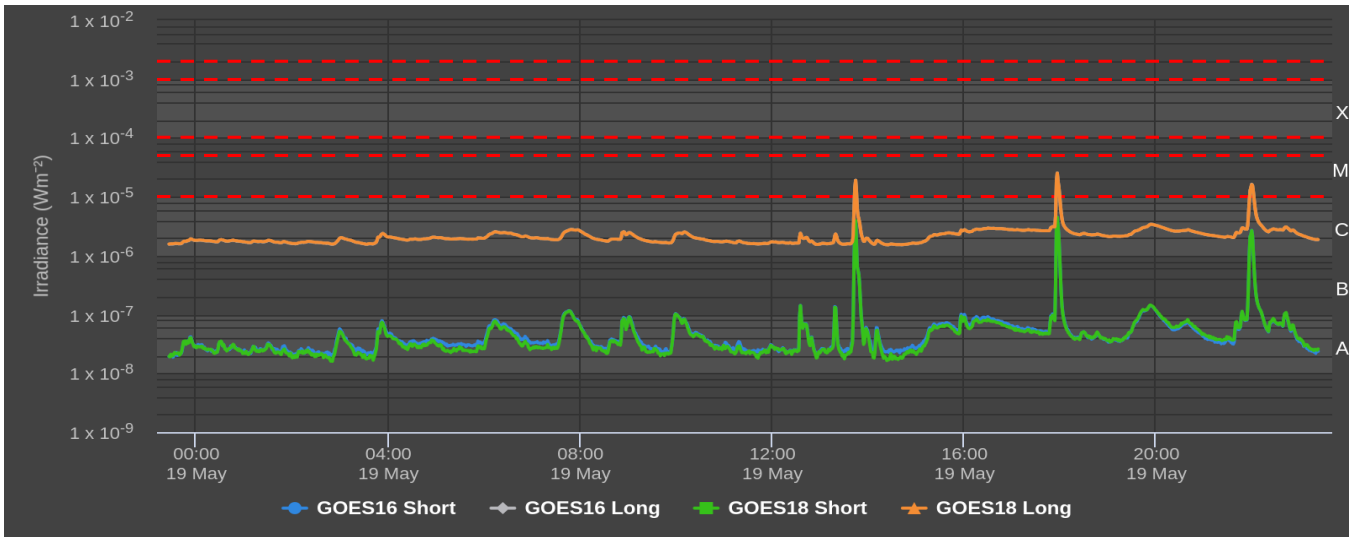
Radio Blackouts - X-Ray Flares:
There are nine sunspot regions on the visible disc. AR3685 (Ehi/Beta-Delta) in the southeast is considered to be the most likely source for significant flare activity, having previously produced X2.9 and M7.2 flares on 15 May and 17 May respectively. The region is composed of a number of large, mature spots with several smaller spots of mixed polarity at present. These smaller spots appear to be consolidating, which consist of a very small delta spot. AR3679 (Esi/Beta-Gamma) near centre-disc in the southern hemisphere is the next largest region and has been the source of some low-level C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 (Dai/Beta) in the southwest indicates modest magnetic complexity with numerous small spots and continued slight development and consolidation. The other sunspot regions are generally smaller, simpler and generally stable.

No significant returning regions are expected through the period or strongly signaled in far-side sounding data, with all the current notable flare producing regions remaining on the visible disc though the next four days. As such, the current flare risks have been maintained through the period pending further developments.

Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of significant flare activity.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-18 X-Ray flare trace



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Solar Radiation Storms - (High Energy Protons):

Proton flux is below the S1/Minor Storm threshold, on a slightly declining trend, but remains just above normal background levels following flare activity from the past week. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. AR3685, the largest and most actively flaring region on the disc will, however, remain in a generally unfavourable position (in the eastern hemisphere) for significant proton enhancement throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 is at background to moderate levels. However there is the potential for electron flux to rise and potentially reach high levels later in the period, with lower orbits having been highly charged by numerous strong CME arrivals in the past week to ten days. Any rise in electron flux may be curtailed by further CME influence however, this considered most likely late day 1 (20 May) or early day 2 (21 May).

The associated 24 hour fluence is expected to follow a generally rising trend through the period with a slight chance to reach the Active threshold by days 3 and 4 (22-23May), though dependent on the extent of any CME enhancement. In the absence of CME enhancements MOSWOC REFM looks to be providing reasonable guidance, although perhaps slightly under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES-16 >2MeV Electron Flux (top) and MOSWOC REFM forecast (bottom).

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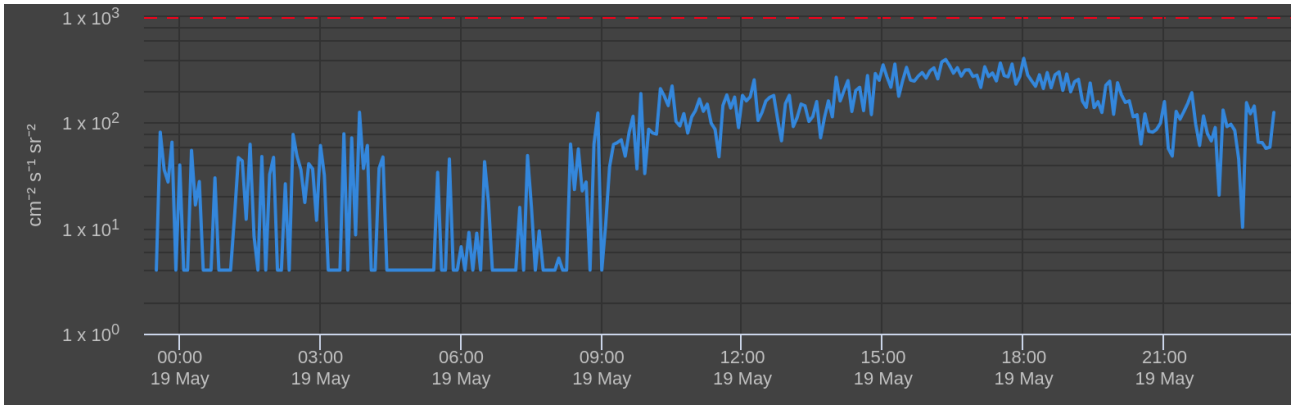

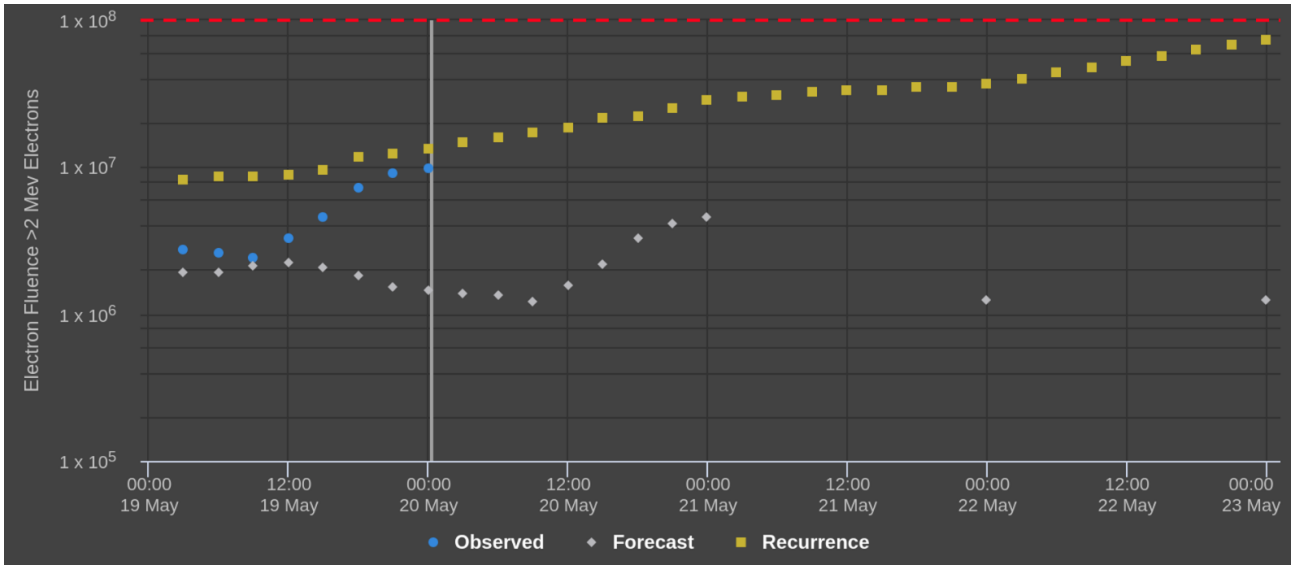

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